A NEW EOCENE SHARK FROM THE LONDON CLAY OF ESSEX

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ABSTRACT. Teeth of a new scyliorhinid shark *Megascyliorhinus cooperi* gen. nov., sp. nov. from the London Clay are described and compared with *M. miocaenicus* (Antunes and Jonet) a Mio–Pliocene species from France, Portugal, and Tunisia, previously referred to *Rhincodon*. It is suggested that the genus *Megascyliorhinus* inhabited fairly deep water.

RECENT collecting at the London Clay (Eocene) locality of Burnham-on-Crouch, by the junior author (D. J. W.), has produced teeth of a new species of scyliorhinid shark. Independent collecting by the senior author (H. C.) at the Neogene localities of La Motte d'Aigues, France and Nabeul, Tunisia has yielded representatives of the same genus, a species previously only recorded from the Miocene of Portugal.

LOCALITIES

1. Burnham-on-Crouch, Essex. This locality is situated about 3 km WNW. of the town of Burnham-on-Crouch. The London Clay is exposed on the north bank of the River Crouch in a foreshore section from map references TQ 920 968 to TQ 922 966. The formation is a stiff blue-grey clay, weathering to brown, and containing occasional mudstones and septaria. From Whitaker and Thresh (1916, pp. 86–111), it is estimated that the base of the clay is 85 m below high-water mark. The invertebrates are characteristic of Wrigley's divisions 3, 4, and 5 of the London Clay (Wrigley 1924 and 1940). The selachian fauna is identical to that listed from Sheppey (Casier 1966) except for the absence of a few species: *Heterodontus wardenensis* Casier, *Myliobatis latidens* Woodward, and *Aetobatis irregularis* Agassiz. There are in addition several species present at Burnham which are so far unknown from Sheppey: *Triakis* sp., *Mustelus* sp., and *Scyliorhinus* spp.

2. La Motte d'Aigues, France. At this locality, situated at the foot of the south face of Grand Lubéron (Vaucluse), there are three superimposed formations each of which yields a rich selachian fauna. The lower is a marl, the middle a sandstone, and the upper a limestone; the latter yielded a few teeth of *Megascyliorhinus miocaenicus*. These formations are considered as Helvetian *s.l.* in age, probably Serravallian.

3. Nabeul, Tunisia. This locality, about 70 km south-east of Tunis, is a large pit where the blue marls have long been worked by local potters. The selachian teeth come from gypsiferous marls interbedded with the blue marls at the base of the outcrop. These marls are considered to be Early Pliocene in age.

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SYSTEMATIC PALAEONTOLOGY

Family SCYLIORHINIDAE Gill, 1862

This family is represented in the London Clay by seven species. The teeth of '*Scyliorhinus*' *biauriculatus* Casier and '*S.*' *minutissimus* (Winkler) are large, and their inclusion in *Scyliorhinus s.s.* is rather doubtful; they somewhat resemble the carcharhinids. *S. gilberti* Casier and three small undescribed species of *Scyliorhinus* closely resemble Recent *Scyliorhinus* teeth (Cappetta 1976). The new species described below is the largest, the anterior teeth reaching 7·5 mm in height.

Megascyliorhinus gen. nov.

Type species. M. cooperi sp. nov.

Referred species. M. miocaenicus (Antunes and Jonet).

Diagnosis. Scyliorhinid known only by isolated teeth; anterior teeth large, curving strongly inwards, lingual face of the crown sometimes striated, labial face particularly convex, smooth or finely striated. The cutting edge, where present, generally does not reach the base of the crown. Root high and broad with flat base and deep median groove; well-developed pair of latero-internal foramina. The lateral teeth asymmetrical, very strongly striated, and may have a pair of lateral denticles.

Megascyliorhinus cooperi gen. nov., sp. nov.

Plate 26, figs. 1–3; Plate 27, fig. 1

Derivation of name. This species is dedicated to Mr. J. Cooper in recognition of his work on the London Clay.

Material. Six complete and three fragmentary teeth from Burnham-on-Crouch. Three worn teeth from Sheppey, previously unnoticed among some upper anterior hexanchid teeth in the collection of the B.M. (N.H.). Figured specimens are housed in the B.M. (N.H.), whose registration numbers are quoted.

Holotype. Anterior tooth, P. 57621. Plate 26, fig. 1*a–d.*

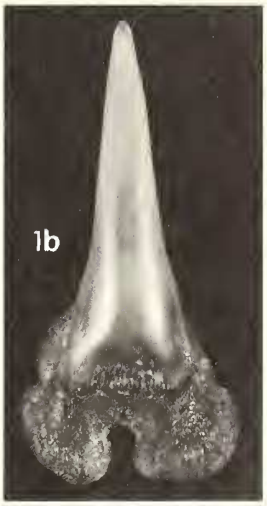
Type locality. Burnham-on-Crouch, Essex, England.

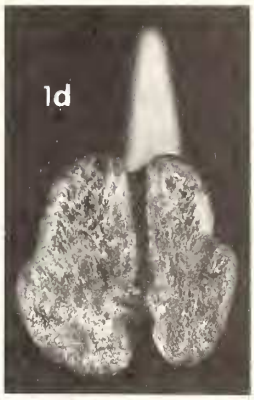
Age. Eocene; Ypresian (London Clay).

Diagnosis. The labial surface of the anterior tooth is inflated towards the bottom of the crown and has short strong parallel striae at its base. The anterior lobes of the root are rounded and outwardly divergent. The root markedly protrudes over the base of the crown in oral view. Extreme lateral teeth have a partially closed root groove.

EXPLANATION OF PLATE 26

Figs. 1–3. *Megascyliorhinus cooperi* gen. nov., sp. nov. ×10. Eocene. Burnham-on-Crouch. In each figure, *a*, lingual face; *b*, labial face; *c*, profile; *d*, base. The registration numbers are of the Department of Palaeontology, British Museum (Natural History). 1, anterior tooth. P. 57621. Holotype. 2, anterior tooth. P. 57624. 3, lower lateral tooth. P. 57622.





CAPPETTA and WARD, new Eocene shark

Description. The holotype (Pl. 26, fig. 1) is an anterior tooth with a pointed crown and rather stout base. The crown strongly curves towards the inside of the mouth and is oblique to the root. The inner surface is strongly convex and is ornamented with numerous fine parallel close-spaced striations on its lower quarter. The outer surface is less convex but has a basal swelling protruding over the anterior surface of the root; the area below this swelling is concave and bears short vertical striations, some of which are fairly well spaced. The junction of the root and crown is constricted.

The root is particularly broad and high; the base is flat and the lobes are separated by a deep groove. The internal protuberance is well developed and separated from the general contour by two notches on the prolongation of the latero-internal foramina. These are well developed and occur singly or paired on the lateral face. The inner surface is rather high; the outer surface is very oblique in profile, following the spread of the root towards the anterior lobes, which are rounded and separated by a deep groove. When seen in profile, the enamel junction is straight and slopes up posteriorly. The cutting edge is restricted to the upper third of the crown.

On a slightly larger anterior tooth, the crown is a little less slanting and the base protrudes less over the anterior surface of the root; the cutting edge occupies half the length of the crown.

The lateral teeth are asymmetrical, their crowns being inclined towards the symphysis. On one tooth (Pl. 26, fig. 3), the striations on the outer surface are restricted to the base of the crown, whereas those on the inner surface cover one-half of its height. On the other hand, another tooth (Pl. 27, fig. 1), of similar size and presumed jaw position, shows striations up to two-thirds of the way up the crown, and in addition bears a single well-developed lateral denticle, the other represented by a small protuberance. By comparison with the modern scyliorhinids, this more striated tooth probably belongs to the upper dentition. On both these teeth, the roots are asymmetrical with a more developed lingual lobe; the root groove is oblique, in line with the inclination of the crown.

One very small lateral tooth shows the same characteristics, with less striation, although more strongly defined and covering almost the whole crown; the root groove is partly covered over.

Megascyliorhinus miocaenicus (Antunes and Jonet), 1970

Plate 27, figs. 2–4

1970 *Rhincodon miocaenicus*, Antunes and Jonet, pp. 152–153, fig. 5; pl. 9, figs. 42–44.

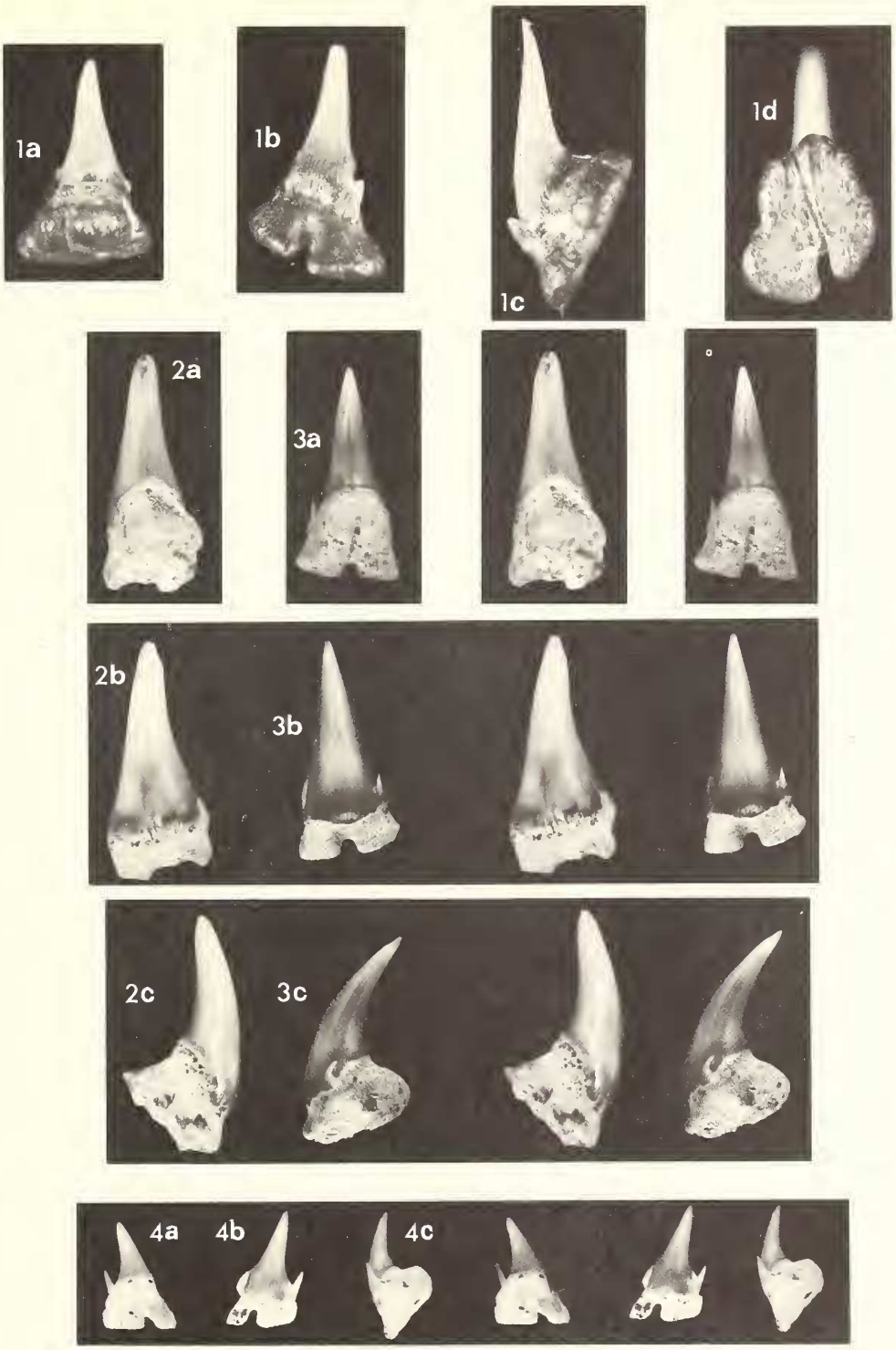
Material. Ten teeth from the Helvetian of La Motte d'Aigues (France) and one tooth from the Pliocene of Nabeul (Tunisia).

EXPLANATION OF PLATE 27

In each figure, *a*, lingual face; *b*, labial face; *c*, profile; *d*, base.

Fig. 1. *Megascyliorhinus cooperi* gen. nov., sp. nov. ×10. Upper lateral tooth. B.M. (N.H.) P. 57623. Eocene. Burnham-on-Crouch.

Figs. 2–4. *Megascyliorhinus miocaenicus* (Antunes and Jonet). ×4. Stereophotographs. The registration numbers are those of the Laboratoire de Paléontologie, Université Montpellier II. 2, anterior tooth. LMA. 1. Helvetian. La Motte d'Aigues. 3, anterior tooth. NAB. 1. Late Pliocene. Nabeul. 4, lateral tooth. LMA. 2. Helvetian. La Motte d'Aigues.



CAPPETTA and WARD, new Eocene shark

Description. (*a*) Miocene specimens. An anterior tooth (Pl. 27, fig. 2*a–c*) has a stout crown and no cutting edge. The labial surface of the crown has a few strong striations below its inflated base. The root is damaged, so that only an indication of its size can be given.

A lateral tooth (Pl. 27, fig. 4*a–c*), lacking a fragment of root, is asymmetrical, its crown being inclined towards the commissure. The lingual surface is very convex; the labial is less so, tending to flatten at the base of the crown. The lingual surface has numerous small wavy striations along its entire height; those of the labial surface are less in number, short in the middle, and longer at the sides. On one side there is a sharp, striated lateral denticle well separated from the main crown; the other is broken. The root is rather high with a strong internal protuberance; its base and outer face are flat, the base is divided by a deep groove.

This lateral tooth is rather different from the anterior teeth, but its general appearance, and in particular its striation and root morphology, favour its inclusion in this species; the presence of denticles on lateral teeth has already been noted in *M. cooperi.*

For a more detailed description of the Miocene species, see Antunes and Jonet (1970).

(*b*) The Pliocene specimen. This anterior tooth (Pl. 27, fig. 3) is slightly smaller than the Miocene specimens but larger than those from the Ypresian. The crown is stout, and leans less towards the inside of the mouth. There is a single lateral denticle, broad at its base but with a sharp backward-pointing tip. The lower third of the inner surface is striated; the outer surface is smooth. The root is robust, rather high, and has a deep groove at its base.

SYSTEMATIC COMPARISON

One can immediately see the similarities between the Eocene and Mio–Pliocene species, and there can be little doubt that they are directly related. Their appearance is similar, but there are sufficient small differences to separate them. The teeth of the Eocene species have a longer crown, which is more inclined towards the inside of the mouth, with many well-defined striations at the base of the outer surface. The root is lower and slightly different in shape: the front is rather oblique and the lobes are quite large. This Ypresian species is quite easy to separate from the other Eocene scyliorhinids, in particular by its combination of large size, striations, and the absence of lateral denticles on the anterior teeth.

The teeth of *M. miocaenicus* are stouter. Their crowns lean less towards the inside of the mouth, the striations at the base of the outer surface are less developed, the root is higher, and the outer surface is subvertical.

The Neogene species cannot be mistaken for any other scyliorhinid. Only the lateral teeth approach those of *Scyliorhinus distans* (Probst), and they can be easily separated by their stouter crown, finer and more numerous striations, the shape of the root, and the more jagged outline of crown and denticles. The Mio–Pliocene teeth agree with those from the Tortonian of Portugal figured by Antunes and Jonet (1970, p. 153, fig. 5 and pl. 9, figs. 42–44) under the name *Rhincodon miocaenicus*; they are anterior teeth without lateral denticles. Antunes and Jonet place in the

synonymy of *R. miocaenicus* the tooth figured in Cappetta (1970) under the name *Rhincodon* sp. from the Helvetian of Loupian, Languedoc, France. Antunes and Jonet state: 'les caractères morphologiques de la racine de ces dents (i.e. *R. miocaenicus*) semblent identiques à ceux de la dent décrite par Cappetta (i.e. *Rhincodon* sp.) mais il y a quelques différences en ce qui concerne la couronne.'

However, these differences are extremely important, particularly in the region of the root. We have examined the teeth of a specimen of the modern whale shark, *R. typus* Smith, from the Seychelles: these teeth are characterized by their small size, by a smooth erect crown with a distinct cutting edge, and by a wide rounded enamel lingual apron, which in profile reaches the base of the root. The root is high, elongated labio-lingually, with a large internal protuberance and a deep groove; the sides are very swollen and the latero-internal foramina are particularly close to the lingual surface. The Loupian tooth corresponds completely with the modern teeth and certainly represents a true *Rhincodon* and not an upper tooth of *M. miocaenicus* as supposed by Antunes and Jonet (1970, p. 154). These authors were probably misled by the figure of a tooth of *R. typus* in Bigelow and Schroeder (1948, p. 190). This illustration is inaccurate because it shows a tooth without its lingual apron, an important feature present in all the teeth we have been able to study, but absent in *M. miocaenicus*. In 1930 White had already, correctly, figured a *Rhincodon* tooth (p. 143, fig. 9). As the species *miocaenicus* does not belong to the genus *Rhincodon*, but instead closely resembles the species *M. cooperi*, it is therefore placed in that new genus. *Megascyliorhinus* is included in the Scyliorhinidae because of its broad similarity with other members of the family, particularly *Scyliorhinus s.s.*; nevertheless, this genus differs from all the genera of the family that we have examined.

STRATIGRAPHIC DISTRIBUTION

Megascyliorhinus first appears in Divisions 3–5 of the London Clay (Ypresian) at Burnham-on-Crouch and Sheppey, England. The tooth described by Brzobohaty and Kalabis (1970, pl. 2, fig. 2*a–b*) from the Oligocene of Pouzdrany, Czechoslovakia, and referred by those authors to *Odontaspis*? sp., is very suggestive of this genus. This anterior tooth shows all the characteristics of the genus. Its crown is typically stocky and inclined, resembling the Eocene species more closely than the Mio-Pliocene one. It can be distinguished from those of the Eocene species by the less prominent anterior lobes of the root and by the presence of a pair of lateral denticles; this feature occasionally appears on anterior teeth, as seen in the Pliocene specimen. The genus is not known again until the Helvetian *s.l.* of La Motte d'Aigues, France where it is represented by *M. miocaenicus*, and again in the Tortonian VII at Mutela in Portugal. The most recent specimen is from the Early Pliocene of Nabeul in Tunisia. This genus probably became extinct in the Pliocene or Pleistocene.

PALAEOECOLOGY

The base of Wrigley's London Clay Division 2 and the base of the Aldwick Beds at Bognor Regis, Sussex mark the influx of a number of shark species which make their first appearance in the English Eocene. These include a few species rare or absent

in contemporary shallow-water deposits in the Paris–Belgian Basin, for example *Notorhynchus serratissimus* (Agassiz), *Xenodolamia eocaena* (Woodward), and *Anomotodon sheppeyensis* (Casier) [= *Oxyrhina sheppeyensis* Casier], all presumed to be deep-water species. In the Miocene, *Megascyliorhinus* is associated with *Deania*, *Centrophorus*, *Pristiophorus*, and *Raja*. Living species of these genera, with perhaps the exception of *Raja*, prefer deep water. At La Motte d'Aigues, where there is a series of closely similar faunas in the Helvetian, *Megascyliorhinus* is restricted to limestone facies at the top, and is absent from the lower marly and sandy facies. In Tunisia, the sole tooth was collected from gypsiferous marls at the base of blue marls rich in otoliths of Myctophidae, which are deep-water fishes. The nature of these deposits and their faunal associations suggest that *Megascyliorhinus* inhabited depths of around 150–200 m.

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